

Project Tasks 8 and 9: Single Heuristic Move to Move again and Single Heuristic Move for Maximum Score By Carrie Corcoran

These are the 8th and 9th tasks of my semester-long project of creating heuristic mancala players. Task 8 involved writing code so that a heuristic player will, when possible, play a move that allows a subsequent move. The rules state that if a player's stone lands in the mancala, the player gets another move. This heuristic can result in long sequences of moves.

The 9th task involved writing code so that a heuristic player will pick the move from those available that will result in the highest score after that move.

Task 8: Single Heuristic Move to Move Again

Code:

```
(defun recursive-again-spaces (player pos spaces)
  (cond
    ((eql player 'a)
     (setf side *side-A*)
     )
    (t
     (setf side *side-B*)
     )
  )
  (cond
    ((= pos 5)
     (cond
       ((and(predict-move-again player (nth 5 side)) (> (get
(nth 5 side) 'value) 0))
        (cons (nth 5 side) spaces)
        )
       (t
        spaces
        )
      )
    )
    (t
     (cond
       ((and(predict-move-again player (nth pos side)) (> (get
(nth pos side) 'value) 0))
        (setf spaces (cons (nth pos side) spaces))
        (recursive-again-spaces player (+ pos 1) spaces)
        )
      )
    )
  )
)
```

```

        (t
          (recursive-again-spaces player (+ pos 1) spaces)
        )
      )
    )
  )
)

(defun heuristic-again-move (player verbose)
  (setf potential-moves (recursive-again-spaces player 0 '()))
  (cond
    ((> (length potential-moves) 0)
      (setf random-num (random (length potential-moves)))
      (setf move (nth random-num potential-moves))
      (cond
        (verbose
          (format t "Move Again Heuristic player picks up stones
in ~A ~%" move)
        )
      )
      (setf again (single-move player move verbose))
      (cond
        ((or (empty-side 'a) (empty-side 'b))
          (format t "Game Over!")
          t
        )
        (again
          (cond
            (verbose
              (format t "Move Again Heuristic player moves
again! ~%")
            )
          )
          (heuristic-again-move player verbose)
        )
      )
    )
  )
  (t
    (format t "No moves found leading to additional move-
picking move randomly. ~%")
    (random-move player verbose)
  )
)
)

```

```
(defun move-again-heuristic-test ()
  (format t "Testing move-again heuristic player: ")
  (reset-board)
  (heuristic-again-move 'a t)
)
```

Demo:

```
[> (move-again-heuristic-test)
```

Testing move-again heuristic player: Move Again Heuristic player
picks up stones in A6

HB	B6	B5	B4	B3	B2	B1	
—	4	4	4	5	5	5	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1
—	4	4	4	4	4	0	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B3

HB	B6	B5	B4	B3	B2	B1	
—	5	5	5	0	5	5	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1
—	5	5	4	4	4	0	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A2

HB	B6	B5	B4	B3	B2	B1	
—	5	5	5	0	5	5	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	2
—	5	0	5	5	5	1	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala

Move Again Heuristic player moves again!

Move Again Heuristic player picks up stones in A6

HB	B6	B5	B4	B3	B2	B1	
—	5	5	5	0	5	5	—
0	—	—	—	—	—	—	—
—	5	0	5	5	5	0	3
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala

Move Again Heuristic player moves again!

Move Again Heuristic player picks up stones in A3

HB	B6	B5	B4	B3	B2	B1	
—	5	5	5	0	5	6	—
0	—	—	—	—	—	—	—
—	5	0	0	6	6	1	4
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B1

HB	B6	B5	B4	B3	B2	B1	
—	6	6	6	1	6	0	—
0	—	—	—	—	—	—	—
—	6	0	0	6	6	1	4
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A1

HB	B6	B5	B4	B3	B2	B1	
—	6	6	6	1	6	0	—
0	—	—	—	—	—	—	—
—	0	1	1	7	7	2	5
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala

Move Again Heuristic player moves again!

Move Again Heuristic player picks up stones in A2

HB	B6	B5	B4	B3	B2	B1	
—	6	6	6	1	6	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	5
—	0	0	2	7	7	2	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A3

HB	B6	B5	B4	B3	B2	B1	
—	6	6	6	1	6	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	5
—	0	0	0	8	8	2	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A5

HB	B6	B5	B4	B3	B2	B1	
—	7	7	7	2	7	1	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	6
—	0	0	0	8	0	3	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B6

HB	B6	B5	B4	B3	B2	B1	
—	0	7	7	2	7	1	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	7
—	1	1	1	9	1	4	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala

Move Again Heuristic player moves again!

Move Again Heuristic player picks up stones in A2

HB	B6	B5	B4	B3	B2	B1	
0	0	7	7	2	7	1	
							7
	1	0	2	9	1	4	
	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A3

HB	B6	B5	B4	B3	B2	B1	
0	0	7	7	2	7	1	
							7
	1	0	0	10	2	4	
	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A5

HB	B6	B5	B4	B3	B2	B1	
0	0	7	7	2	7	1	
							8
	1	0	0	10	0	5	
	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala

Move Again Heuristic player moves again!

No moves found leading to additional move- picking move randomly.

Random player picks up stones in A6

HB	B6	B5	B4	B3	B2	B1	
0	0	7	8	3	8	2	
							9
	1	0	0	10	0	0	
	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B4

HB	B6	B5	B4	B3	B2	B1	
—	1	8	0	3	8	2	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	9
—	2	1	1	11	1	1	—
—	—	—	—	—	—	—	—
A1	A2	A3	A4	A5	A6	HA	

Player picks up stones in opposite space and places them in the player's mancala

HB	B6	B5	B4	B3	B2	B1	
—	1	8	0	3	8	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	11
—	2	1	1	11	1	1	—
—	—	—	—	—	—	—	—
A1	A2	A3	A4	A5	A6	HA	

NIL

[4]> (move-again-heuristic-test)

Testing move-again heuristic player: Move Again Heuristic player picks up stones in A5

HB	B6	B5	B4	B3	B2	B1	
—	4	4	4	4	5	5	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1
—	4	4	4	4	0	5	—
—	—	—	—	—	—	—	—
A1	A2	A3	A4	A5	A6	HA	

Picking up stones in B2

HB	B6	B5	B4	B3	B2	B1	
—	5	5	5	5	0	5	—
0	—	—	—	—	—	—	
	5	4	4	4	0	5	1
—	—	—	—	—	—	—	—
	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A1

HB	B6	B5	B4	B3	B2	B1	
—	5	5	5	5	0	5	—
0	—	—	—	—	—	—	
	0	5	5	5	1	6	1
—	—	—	—	—	—	—	—
	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A6

HB	B6	B5	B4	B3	B2	B1	
—	5	6	6	6	1	6	—
0	—	—	—	—	—	—	
	0	5	5	5	1	0	2
—	—	—	—	—	—	—	—
	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B5

HB	B6	B5	B4	B3	B2	B1	
—	6	0	6	6	1	6	—
0	—	—	—	—	—	—	
	1	6	6	6	2	0	2
—	—	—	—	—	—	—	—
	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A5

HB	B6	B5	B4	B3	B2	B1	
—	6	0	6	6	1	6	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	3
—	1	6	6	6	0	1	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala

Move Again Heuristic player moves again!

Move Again Heuristic player picks up stones in A6

HB	B6	B5	B4	B3	B2	B1	
—	6	0	6	6	1	6	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	4
—	1	6	6	6	0	0	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala

Move Again Heuristic player moves again!

Move Again Heuristic player picks up stones in A1

HB	B6	B5	B4	B3	B2	B1	
—	6	0	6	6	1	6	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	4
—	0	7	6	6	0	0	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A2

HB	B6	B5	B4	B3	B2	B1	
—	6	0	6	6	2	7	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	5
—	0	0	7	7	1	1	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B2

HB	B6	B5	B4	B3	B2	B1	
—	6	0	7	7	0	7	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	5
—	0	0	7	7	1	1	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B4

HB	B6	B5	B4	B3	B2	B1	
—	7	1	0	7	0	7	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	5
—	1	1	8	8	2	1	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A5

HB	B6	B5	B4	B3	B2	B1	
—	7	1	0	7	0	7	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	6
—	1	1	8	8	0	2	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala

Move Again Heuristic player moves again!

Move Again Heuristic player picks up stones in A6

HB	B6	B5	B4	B3	B2	B1	
—	7	1	0	7	0	8	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	7
—	1	1	8	8	0	0	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B1

HB	B6	B5	B4	B3	B2	B1	
—	8	2	1	8	1	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	7
—	2	2	9	8	0	0	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A3

HB	B6	B5	B4	B3	B2	B1	
—	8	3	2	9	2	1	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	8
—	2	2	0	9	1	1	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B5

HB	B6	B5	B4	B3	B2	B1	
—	9	0	2	9	2	1	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	8
—	3	3	0	9	1	1	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A2

HB	B6	B5	B4	B3	B2	B1	
—	9	0	2	9	2	1	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	8
—	3	0	1	10	2	1	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A5

HB	B6	B5	B4	B3	B2	B1	
—	9	0	2	9	2	1	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	9
—	3	0	1	10	0	2	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala

Move Again Heuristic player moves again!

Move Again Heuristic player picks up stones in A6

HB	B6	B5	B4	B3	B2	B1	
—	9	0	2	9	2	2	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	10
—	3	0	1	10	0	0	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B1

HB	B6	B5	B4	B3	B2	B1	
—	9	0	2	10	3	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	10
—	3	0	1	10	0	0	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B3

HB	B6	B5	B4	B3	B2	B1	
—	10	1	3	0	3	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	11
—	4	1	2	11	1	1	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala

Move Again Heuristic player moves again!

Move Again Heuristic player picks up stones in A3

HB	B6	B5	B4	B3	B2	B1	
—	10	1	3	0	3	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	11
—	4	1	0	12	2	1	—
—	—	—	—	—	—	—	—
A1	A2	A3	A4	A5	A6	HA	

Picking up stones in A5

HB	B6	B5	B4	B3	B2	B1	
—	10	1	3	0	3	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	12
—	4	1	0	12	0	2	—
—	—	—	—	—	—	—	—
A1	A2	A3	A4	A5	A6	HA	

Last stone placed in player's mancala

Move Again Heuristic player moves again!

No moves found leading to additional move- picking move randomly.

Random player picks up stones in A1

HB	B6	B5	B4	B3	B2	B1	
—	10	1	3	0	3	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	12
—	0	2	1	13	1	2	—
—	—	—	—	—	—	—	—
A1	A2	A3	A4	A5	A6	HA	

Player picks up stones in opposite space and places them in the player's mancala

HB	B6	B5	B4	B3	B2	B1	
—	10	1	3	0	0	0	—
0	—	—	—	—	—	—	—
—	0	2	1	13	1	2	15
—	—	—	—	—	—	—	—
	A1	A2	A3	A4	A5	A6	HA

NIL

Task 9: Single Move for Max Score Heuristic

Code:

```
(defun heuristic-max-score-move (player verbose)
  (cond
    ((eql player 'a)
     (setf side *side-A*)
     )
    (t
     (setf side *side-B*)
     )
  )
  (setf scores (recursive-move-score-spaces player 5 '()))
  (format t "Scores: ~A ~%" scores)
  (setf pos (position (apply 'max scores) scores))
  (setf move (nth pos side))
  (format t "Position: ~A ~%" move)
  (cond
    (verbose
     (format t "Maximum Score Heuristic player picks up stones
in ~A ~%" move)
     )
  )
  (setf again (single-move player move verbose))
  (cond
    (again
     (cond
       (verbose
        (format t "Maximum Score Heuristic player moves again!
~%")
        )
      )
    )
  )
  (heuristic-max-score-move player verbose)
)
```

```
)

(defun max-score-heuristic-test ()
  (format t "Testing max score heuristic player: ")
  (reset-board)
  (heuristic-max-score-move 'a t)
)
```

Demo:

```
[> (max-score-heuristic-test)
Testing max score heuristic player: Scores: (5 4 1 6 3 2)
Position: A4
Maximum Score Heuristic player picks up stones in A4
```

HB	B6	B5	B4	B3	B2	B1	
—	4	4	4	4	4	5	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1
—	4	4	4	0	5	5	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B1

HB	B6	B5	B4	B3	B2	B1	
—	5	5	5	5	5	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1
—	4	4	4	0	5	5	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B6

HB	B6	B5	B4	B3	B2	B1	
—	0	5	5	5	5	0	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1
—	5	5	5	1	6	5	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A5

HB	B6	B5	B4	B3	B2	B1	
—	0	5	6	6	6	1	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	2
—	5	5	5	1	0	6	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B4

HB	B6	B5	B4	B3	B2	B1	
—	1	6	0	6	6	1	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	2
—	6	6	6	2	0	6	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A4

HB	B6	B5	B4	B3	B2	B1	
—	1	6	0	6	6	1	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	2
—	6	6	6	0	1	7	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A6

HB	B6	B5	B4	B3	B2	B1	
—	2	7	1	7	7	2	—
0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	3
—	6	6	6	0	1	0	—
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B6

HB	B6	B5	B4	B3	B2	B1	
—	0	7	1	7	7	2	—
0	—	—	—	—	—	—	—
—	7	7	6	0	1	0	3
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A2

HB	B6	B5	B4	B3	B2	B1	
—	0	7	1	7	8	3	—
0	—	—	—	—	—	—	—
—	7	0	7	1	2	1	4
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B2

HB	B6	B5	B4	B3	B2	B1	
—	1	8	2	8	0	3	—
0	—	—	—	—	—	—	—
—	8	1	8	2	2	1	4
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A4

HB	B6	B5	B4	B3	B2	B1	
—	1	8	2	8	0	3	—
0	—	—	—	—	—	—	—
—	8	1	8	0	3	2	4
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in A6

HB	B6	B5	B4	B3	B2	B1	
—	1	8	2	8	0	4	—
0	—	—	—	—	—	—	—
—	8	1	8	0	3	0	5
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B1

HB	B6	B5	B4	B3	B2	B1	
—	1	9	3	9	1	0	—
0	—	—	—	—	—	—	—
—	8	1	8	0	3	0	5
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

Picking up stones in B5

HB	B6	B5	B4	B3	B2	B1	
—	2	0	3	9	1	1	—
0	—	—	—	—	—	—	—
—	9	2	9	1	4	1	6
—	—	—	—	—	—	—	—
—	A1	A2	A3	A4	A5	A6	HA

NIL